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Infectious disease mortality in British merchant seamen and Lascars since 1900: From causes to controls[1]

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Abstract

Trends in mortality rates from infectious disease in seamen employed in British merchant shipping have been compared with those in the Royal Navy and with the onshore male working-age British population. Merchant seamen, and in particular those recruited from Asia (Lascars), had higher mortality rates than men in the Navy and in the population ashore. Mortality declined progressively between 1900 and 1960, thereafter it was negligible; the decline was slowest for merchant seamen. The reasons for the high mortality from infectious diseases in merchant seamen are investigated. Some preventative measures, such as vaccination for smallpox, were not universal in merchant seamen. Improvements prior to the 1940s can be attributed to reduced infection risks in foreign ports; improvements in food, accommodation and hygiene standards, and better control of arthropod vectors in port on board. The rapid subsequent decline can be attributed to the introduction of anti-bacterial medications and antibiotics.

Keywords

merchant seamen, Royal Navy, infectious disease, mortality

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[1] The authors are grateful to libraries at the Wellcome Trust and the Institute of Naval Medicine for provision of documents and helpful advice, and also to the Registry of Shipping and Seamen and the Marine Accident Investigation Branch for advice and for providing access to their death inquiry files, death notification files and death registers.

Introduction

Reviewing trends in infectious diseases in seamen and assessing reasons for them is complex. Until the second half of the nineteenth century infectious diseases were classified in what are often now unfamiliar ways: miasmatic and contagious, or continuing and intermittent fevers and exanthems (infections associated with a skin rash). There was little reliable data, beyond a few hospital-based case series on their incidence or on morbidity and mortality from them.[2] By 1900, however, most infections were named and classified either according to the organism that was responsible for them or based on a well-defined set of characteristic signs and symptoms. This has made the investigation of subsequent mortality trends feasible, but with some limitations arising from the quality of diagnostic information.

These changes in infectious disease nomenclature reflected the development of germ theories of infection, coupled with better observational characterisation of those conditions where causative organisms had yet to be identified.[3] A consequence was the development of the better understanding of causation that was needed to underpin any rational approach to prevention and to the development of non-empirical methods for treatment. This study assesses the pace at which new knowledge about causation, preventative techniques, methods of diagnosis and the development of better treatments have influenced infectious disease mortality in merchant seamen working aboard British registered vessels.

In the United Kingdom, data on merchant seamen's mortality (there were very few female seafarers), if not on morbidity, had been collected as part of wider statutory notification procedures concerned with loss of life at sea since the mid-late nineteenth century.[4] Trends in this group are compared with those in the Royal Navy (RN) and in the onshore male working age population from 1900. The RN produced detailed annual returns on the health of their officers and ratings, while the causes of death in the onshore working age male population are available from

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[2] Gordon Cook, 'Disease in the nineteenth century merchant navy: the seamen's hospital experience', *Mariner's Mirror,* 78 (2001), 460-71. Thomas Roe, Memorandum in answer to question number 10. *Replies of British Consuls to a circular letter from the Board of Trade requesting (1) suggestions with regard to the Merchant Shipping Bill of 1869. (2) Returns and answers on certain points connected with British shipping,* British Parliamentary Papers (BPP), 1872 [C.360], LII, 155.

[3] Michael Worboys, *Spreading Germs: Disease Theories and Medical Practice in Britain 1865-1900* (Cambridge, 2000).

[4] Tim Carter, *Merchant Seamen's Health 1860-1960: Medicine, Technology, Shipowners and the State in Britain* (Woodbridge, 2014), 48.

official mortality reports. Long-term trends in naval mortality have been analysed in a limited way in the past.[5] No comparable long-term studies of infectious disease mortality have been performed before for merchant seamen. Studies of disease mortality among seamen in British merchant shipping were undertaken for short periods in the 1920s and 1930s.[6] Internationally in more recent decades, a number of shorter time series for disease mortality have been published.[7] An article, based on the same population to that which is studied here, identified that merchant seamen were at far higher risk of dying from a range of infectious diseases than any other section of the population of Britain.[8]

For a range of infections, the response to new knowledge on disease prevention and treatment, as indicated by mortality data, was slower and less comprehensive for merchant seamen than in the naval and onshore populations. The reasons for this may include increasing recruitment from global regions where infectious diseases were endemic, greater exposure to infection risks, especially in tropical ports and in those locations where interventions to safeguard public health were absent, as well as the lack of up to date information on risks, means of prevention and treatment. New information was formally provided to merchant shipping by means of the relatively infrequent revisions of the *Ship Captain's Medical Guide* (SCMG).[9] In addition living and working conditions on merchant ships,

[5] F.P. Ellis, 'The Health of the Navy: the Changing Pattern', *British Journal of Industrial Medicine,* 26 (1969), 190-201.

[6] William E. Home, 'An Attempt to Provide a Standard Death Rate for Merchant Seamen', *The Lancet*, 207 (1926), 828-30, 877; and P.G. Edge, *Statistics Relating to Mortality in the Merchantile Marine: Report of the London School of Hygiene and Tropical Medicine* (London, 1932), 51.

[7] Anders Otterland*, A Sociomedical Study of the Mortality in Merchant Seafarers* (Gothenburg, 1960); Bogdan Jaremin, Ewa Kotulak, Maria Starnawska and Stanislaw Tomaszunas, 'Causes and circumstances of deaths of Polish seafarers during sea voyages', *Journal of Travel Medicine*, 3, No. 2 (1996), 91-5; Henrik L. Hansen, 'Surveillance of deaths on board Danish merchant ships, 1986-93: implications for prevention', *Occupational and Environmental Medicine*, 53, No. 2 (1996), 269-75; Detlef Nielsen, Henrik L. Hansen, Bernard M. Gardner and Dietmar Jungnickel, 'Deaths due to disease of seafarers on board Singapore ships', *International Maritime Health*, 51 (2000), 20-29; Stephen E. Roberts, 'Mortality from disease among seafarers in British merchant shipping, 1976-1995', *International Maritime Health*, 53 (2002), 43-58; Stephen E. Roberts, 'Work-related mortality among British seafarers employed in flags of convenience shipping, 1976-95', *International Maritime Health* 54 (2003), 7-25; Marcus Oldenburg, Jan Herzog and Volker Harth, 'Seafarer deaths at sea: a German mortality study', *Occupational Medicine (Lond)*, 66 (2016), 135-7.

[8] Stephen E. Roberts and Tim Carter, 'British merchant seafarers 1900-2010: A history of extreme risks from infectious disease', *Travel Medicine and Infectious Disease,* 14 (2016), 499-504.

[9] *The Ship Captain's Medical Guide.* 1868-1999. (London: Simkin Marshall to 1906. London: HMSO from 1912). H. Leach, 1st Edition, 1868; 6th Edition, 1874; W. Spooner, 9th Edition, 1885; 12th Edition, 1899; 13th Edition, 1901; C. Burland, 15th Edition, 1912; D. MacIntyre, 17th Edition, 1929; Anon, 18th Edition, 1946; M. Morgan (Editor), 19th Edition, 1952; 20th Edition, 1976; Anon, 21st Edition, 1983; C. Cahill (Editor), 22nd Edition, 1999.

seamen's attitudes to risk, the motivation and competence of ships' officers to take effective action when infections arose, and the political and economic climate within which merchant shipping operated are all likely to have contributed to this delay.

A significant proportion of crew members on British merchant ships came from locations such as India and China, where the incidence of many infections was higher. These seafarers were employed on less favourable 'Asiatic contracts' and were grouped together as 'Lascars'.[10] Their deaths were recorded separately from the other (mainly British) seamen for much of the period, and their pattern of mortality for some infections differs from that of other merchant seamen and can also be seen to contribute to the continuing incidence of some infections at a time when their frequency among ethnic British populations was low.

Methods

Annual returns on mortality among merchant seamen serving in UK merchant shipping have been published from the mid-late nineteenth century to 1988. Their prime purpose was to keep a tally of loss of life at sea. These returns were based on individual reports of death that were submitted by ships' captains and British consuls in order to ensure deaths were formally documented and that all wages due were paid. From the late 1880s, following the major Royal Commission inquiry into deaths at sea published in 1885, these returns included information on any illnesses that were a cause of death.[11] These data were compiled by the Registry of Shipping and Seamen (RSS), previously the Registrar General of Shipping and Seamen.

Information on deaths from infectious diseases among seafarers employed in UK merchant shipping from 1900-2010 came from the following sources: first, from the annual death returns published variously by the Board of Trade, the Ministry of Transport, the Department of Trade and Industry, the Department of Industry, the Department of Trade and the Department of Transport up to 1988.[12] Information for

[10] Tim Carter, *Merchant Seamen's Health,* 83.

[11] *First Report of the Royal Commission on Loss of Life at Sea*, BPP 1884-5 [C.4577], XXXV.

[12] *Return of Shipping Casualties and Deaths. Vessels Registered in the United Kingdom* [annual returns for 1909-1911, 1913, 1914]; *Return of Shipping Casualties and Deaths. Vessels Registered in the United Kingdom* [annual returns for 1919-38]; *Shipping Casualties and Deaths. Vessels Registered in the United Kingdom* [annual returns for 1964-68]; *Return of Shipping Casualties and Deaths: Vessels Registered in*

more recent years came from the examination of death inquiry files, death registers and death notifications at the RSS (from 1976) and the Marine Accident Investigation Branch (from 1990). By 1960 most infectious diseases had become very rare causes of death in seafarers, as a result of better prevention and treatment. For this reason we concluded our commentary of trends at this date, while presenting later trends in graphic form to show the lack of infectious disease mortality. Since 1960 malaria has continued to cause a few deaths in seafarers and occasional new causes of mortality have been identified, such as hepatitis B and HIV infections.

The inclusion of infectious diseases in this study of mortality was restricted necessarily, firstly, to those infections that were recorded consistently in the death returns for UK merchant shipping and for the two reference populations, the RN and the general onshore population. Secondly, it was restricted to infectious diseases that resulted in substantial mortality and that were also recorded over a substantial number of years in the death returns for the three populations. This resulted in 13 infectious diseases for study: typhoid, dysentery, cholera, smallpox, tuberculosis, influenza, diphtheria, scarlet fever, malaria, typhus, plague, yellow fever and syphilis.

For merchant seamen, the study included deaths from these infectious diseases among those employed on board UK merchant ships of 100 gross tonnes or more that occurred at sea or in foreign ports or following discharge ashore in a foreign country. The study usually excluded deaths that occurred more than a few days after discharge in the UK, as these were registered along with the general population rather than as seafarers through the RSS. For the acute conditions studied these sources give a valid picture, but they cannot be used to make an assessment of long delayed infectious disease deaths in seamen, for instance from tuberculosis or syphilis.[6]

The populations of seafarers employed annually in UK merchant ships were obtained from the annual deaths returns (Figure 1). Conventionally, the seafarers were counted as if they had been working at sea for the entirety of each year, in order to enable more direct comparisons of mortality with other industries. This is because, although seafarers often have periods of shore leave which may be for several months each year, unlike most other occupations, seafarers have a much greater duration of occupational exposure when at sea.

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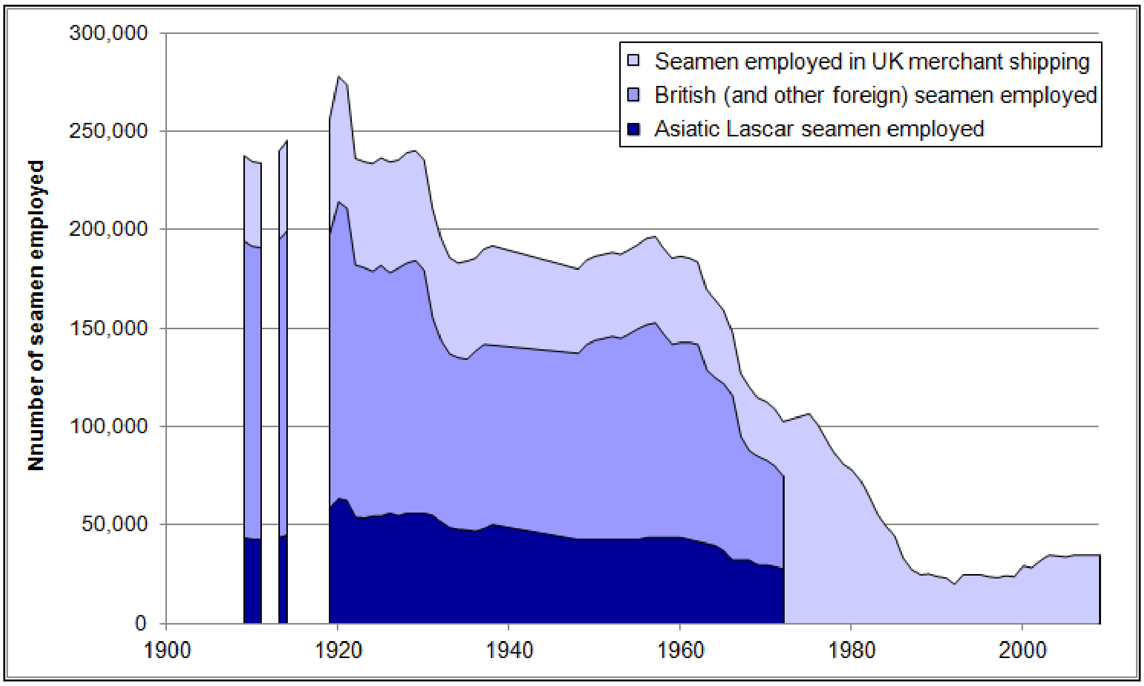
the United Kingdom [annual returns for 1948-63 with summary tables for the years 1939-47]; *Shipping Casualties and Deaths. Vessels Registered in the United Kingdom* [annual returns for 1969-88].

The size of the RN population during the available peacetime years varied between 83,000 in 1933 and 139,000 in 1953. The population crewing the British merchant fleet in peacetime fell from 279,000 in 1920 to 20,000 by 1992, but has increased in more recent years to 35,000.

Figure 1. Populations of Seamen Employed in UK Merchant Shipping



Notes
Deaths in Asiatic Lascars ceased to be recorded separately after 1972.
Some annual returns were not available prior to 1919.

Trends in mortality from the infections studied were compared with those in the corresponding male working aged population (15-64 years) of England and Wales using death certificate data from the Office for National Statistics (ONS) from 1901 to 2010,[13] and among crews serving in the RN. Mortality rates for the male working age population were calculated using the annual death counts and residential populations of England and Wales. Mortality rates for the RN were similarly calculated using information on causes of death and populations employed from

[13] Office for National Statistics, *Twentieth Century Mortality: 95 years of mortality data in England & Wales* [CD-ROM]. (London, 1997); Office for National Statistics, *Mortality Statistics: Cause: Series DH2 and DR* [annual returns for 1998–2010] (London, 1999-2011).

annual RN death returns.[14] These two reference populations have marginally different inclusion criteria for the population denominators. They also have more rigorous procedures for identifying causes of death than those used for merchant seamen, which are likely to result in better ascertainment of cause and to more delayed deaths being included.

The main outcome measures were mortality rates per 100,000 population at risk, used to compare mortality in British merchant shipping with the two reference populations. Other methods of analysis include time trends in mortality rates for the years that these data are available (Tables 1 and 2) and trends in relative risk comparisons to compare mortality in merchant shipping with the reference populations (Tables 3 and 4). Over the study period from 1900 to 2010, annual details of mortality and populations at risk were obtained for 97 of the 111 years for British merchant shipping (1909-1911, 1913-1914 and from 1919-2010) and for 43 years for the Royal Navy (1900-1915, 1921-1936 and 1953-1963). Missing years were because the annual death returns – despite exhaustive searches – could not be located or were not released. When comparing mortality in British merchant shipping with the reference populations, only those years when mortality was available for all groups were used.

The chronology of major developments in identifying causes of infection, proposing preventative regimens and developing new forms of treatment were obtained from a range of primary and secondary sources for each of the conditions studied. For some conditions and interventions the timing was precise, while for others it lacked precision, sometimes because of continuing public health or academic debate and in other circumstances because of inherent conservatism or doubts about the practicability of changes to practice. *The Ship Captain's Medical Guide* (*SCMG*), the major source of information on recommended practice on board merchant ships, only included changes to practice when they were well established in other settings.[15] Records in the National Archives, in wartime circulars and in

[14] *Statistical Report on the Health of the Navy* [annual returns from 1900 to 1936]; Medical Director General, Admiralty, 'Report on the Health of the Navy for the years 1953 to 1956', Institute of Naval Medicine Archives, Gosport, B.R. 26(I); Ministry of Defence, Medical Director General (naval), 'Report on the health of the Royal Navy and Royal Marines 1957 to 1963, Institute of Naval Medicine Archives, Gosport, n/MDG213/1/67/R.

[15] Tim Carter, 'The *Ship Captain's Medical Guide* and the management of infectious disease at sea 1867-1967' (Unpublished MA Thesis, University of Greenwich, 2010).

medical journals provided supplementary information on the state of knowledge about interventions at sea.

Results

The analysis of the mortality data for merchant seamen and comparisons with the Navy and the onshore population have been used to address four questions. First, what effects does new knowledge on prevention and treatment have on trends in mortality from infectious disease in merchant seamen? Second, how does this compare with the trends in the two comparison groups of naval crews and the onshore male population aged 15-64? Third, what effect do the different geographical origins and ethnic make up of the populations have on infectious disease mortality? Finally, to what extent do patterns of exposure to risk of infection influence mortality?

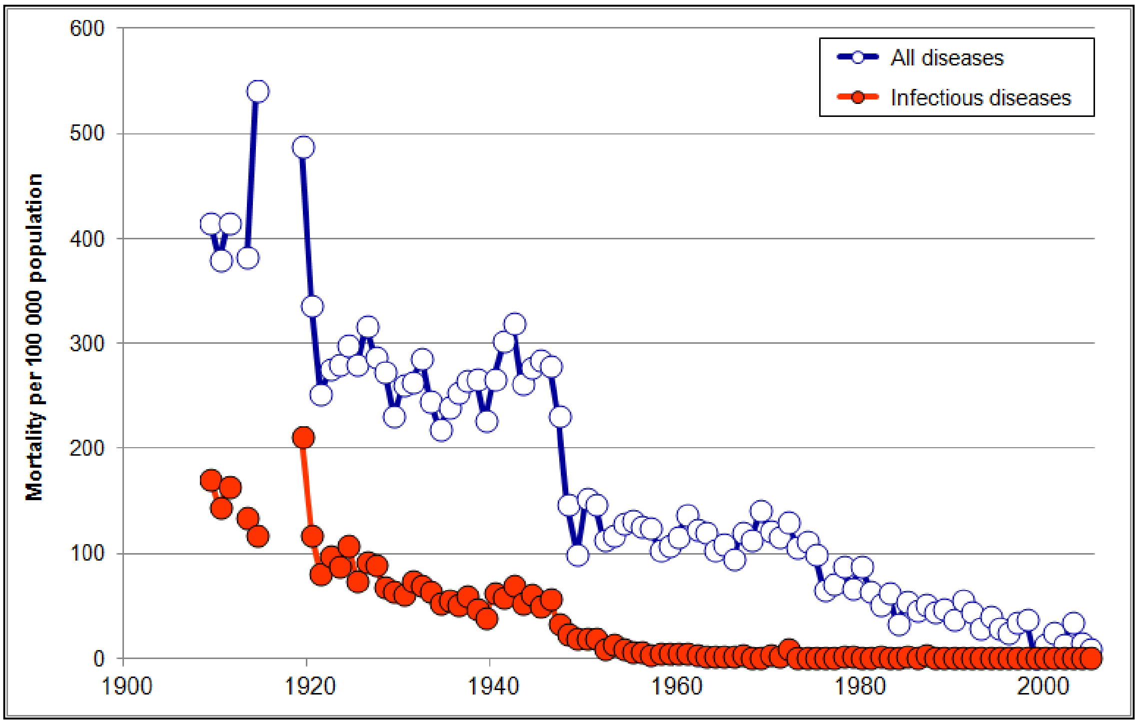
Throughout almost all of the study period, there is a decline in overall mortality from disease among merchant seamen, and little mortality from infectious diseases by 1960 (Figure 2). There are increased mortality rates from most of the infectious diseases investigated in both merchant seamen and in the RN. The incidence is, in most cases, substantially higher in merchant seamen than in the Navy (Tables 1 and 2). The relative risk of death from the various infectious diseases (Tables 3 and 4) makes apparent the patterns of excess mortality, when compared to the onshore male population of working age. This is most notable for tropical diseases and is slower to decline in merchant seamen than in the Navy. These trends are shown in detail below for each recorded infectious disease.

Because most of the preventative methods relate to the mode of transmission of the disease, the results are grouped into those transmitted by food and water; those transmitted by airborne droplets or by contaminated surfaces; those with arthropod vectors; and finally those passed on in body fluids. The range of infections studied is necessarily limited by the headings under which mortality data was classified in all three populations.[16]

[16] William Home, 'The Deaths of Merchant Seamen in 1923', *The Lancet,* 206 (1924), 731-4.

Many infections are or were widely distributed geographically across different groups of the population (typhoid, influenza). However, for some infections, the requirements for transmission mean that they only occur in limited geographical settings (malaria, yellow fever). For others there have been major differences in frequency in different locations because of local endemicity (smallpox, amoebic dysentery). A few are likely to be more prevalent in seafarers because of working or living conditions or from lifestyle constraints (tuberculosis, syphilis, typhus). Some, such as plague, cholera and influenza are characterised by occasional epidemic spread.

Figure 2. **Mortality Rates from Infectious Diseases and from all Diseases in UK Merchant Shipping**

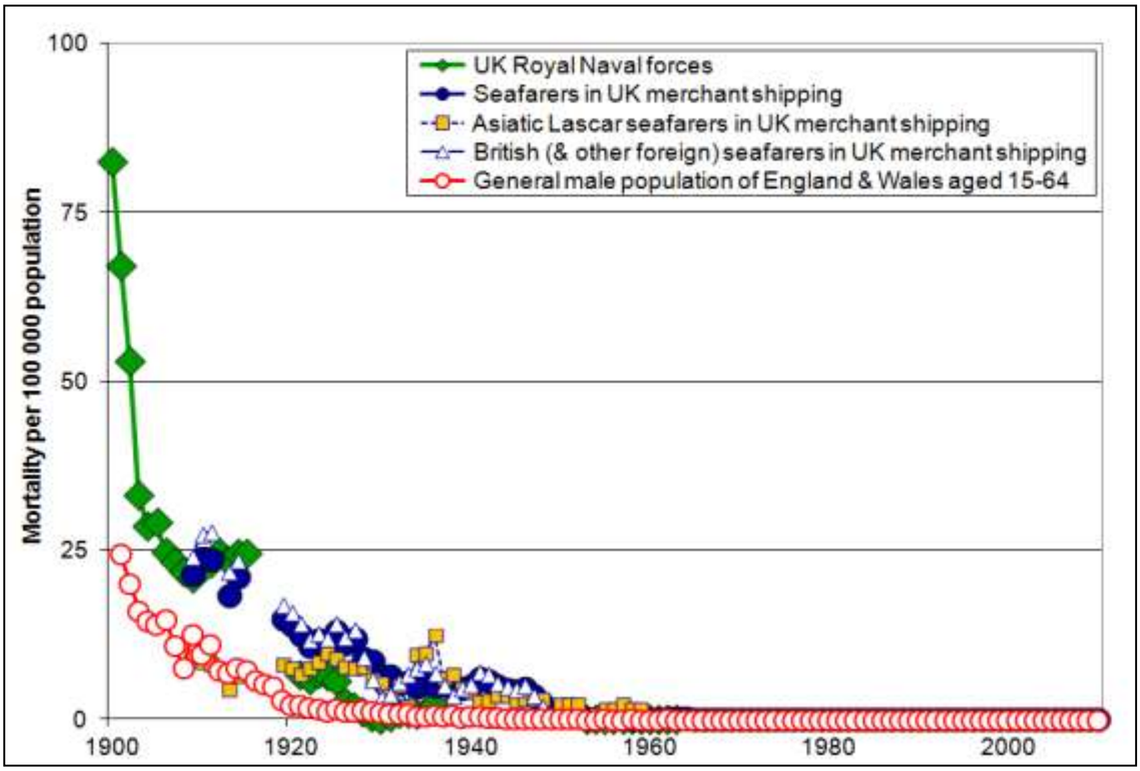


Notes
Infectious disease mortality trends shown relate to the 13 specific diseases discussed in this study.
Deaths attributed to some infections that are localised or which have multiple causes such as pneumonias, septicaemia and abscesses were not recorded as infectious diseases in the annual death returns.
Some annual death returns were not available prior to 1919.

Food and Water Transmission: Typhoid

Typhoid was common in Britain until around 1920. Both merchant and naval seamen show higher mortalities than the land-based population, but with a slower decline in merchant seamen (Figure 3). The causal organism was identified in the 1880s and the link between food and water contamination and infection was rapidly recognised, being noted in the 1885 edition of *SCMG*, with the distinguishing features of typhus and typhoid tabulated in 1901. However, it was stated to still be unusually frequent in merchant seamen, including those in the coasting trades, in the early twentieth century.[17] There is no evidence of widespread use of immunisation in merchant seamen and, perhaps surprisingly, there is no recorded excess mortality among Lascar seamen recruited from Asia when compared with other seamen.

Figure 3. Typhoid Mortality Rates



[17] William Collingridge, 'Health in the Marine Service' in Thomas Oliver, ed., *Dangerous Trades: The Historical, Social, and Legal Aspects of Industrial Occupations as affecting Health* (London, 1902), 187.

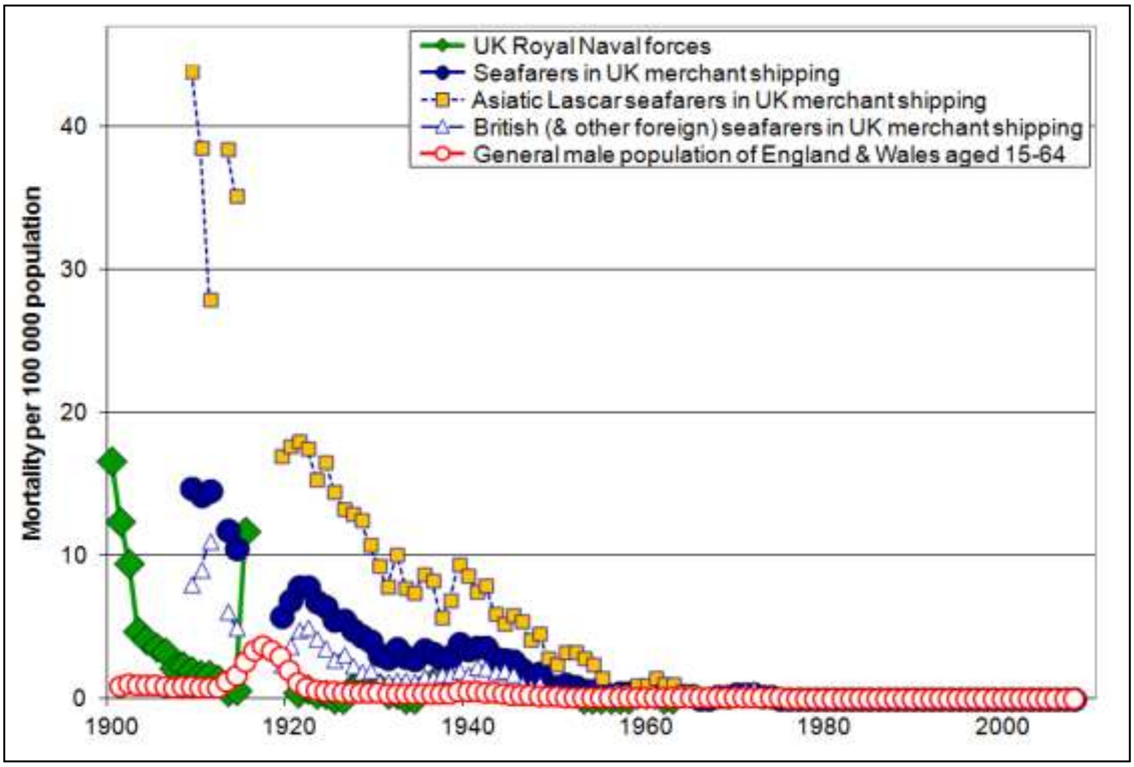
The decline in mortality was relatively steady in both merchant and naval populations, presumably associated with improved water quality and food hygiene and a reduction in sources of infection from the wider community or from chronic carriers. Whether the near starvation diets recommended in *SCMG* until 1929 improved prognosis and affected mortality rates is not clear. Definitive treatment became available with the use of chloramphenicol in 1948, but by this time the disease was uncommon.

Food and Water Transmission: Dysentery (bacterial and amoebic)

As early as the first edition of *SCMG* in 1868 the high incidence of dysentery in ships trading to China and the East Indies was noted. The amoeba responsible for one form (amoebic) was recognised in 1875 and the *Shigella* bacteria was shown to be the cause of the other (bacterial) form in 1897. Both were found in contaminated food and water. The different diagnostic features of bacterial and amoebic forms were clarified in 1912. Harsh regimes of treatment using emetics and purgatives were initially recommended but progressively replaced by ones using fluid replacement, with the addition of antibacterials, such as sulphguanidine, in the 1940s.

Mortality trends in the early part of the twentieth century are complex, with peaks in onshore and naval mortality during the period around the First World War (Figure 4). Thereafter dysentery was a negligible cause of mortality in the naval and onshore populations. In the Navy the adoption of hygiene standards for food and water supply was far more effective than comparable measures in merchant shipping, where procurement was dependent on local shipping agents in each port. Among merchant seamen dysentery was far commoner in Asian seafarers than in others. This appeared to continue into the 1950s despite the availability of effective treatments. This may reflect the long-term consequences from liver abscesses in the amoebic form of the condition, but there is no available information that can confirm this as the annual death returns continued to place both forms of dysentery in a single category as a cause of death.

Figure 4. **Dysentery Mortality Rates**



Food and Water Transmission: Cholera

Throughout the nineteenth century, there were repeated cholera pandemics across Europe.[18] Transmission was by overland and seaborne movements of infected people.[19] For this reason there was active case detection and isolation in place in most major British and Northern European ports by 1900.[20] In 1883 the cholera bacillus was identified and shown to be causal. Waterborne transmission was identified at the main route of infection and this was reflected in the advice given in the 1899 *SCMG*. By 1912 the *SCMG* stated that cholera was a high risk on Asian, Indian and pilgrim routes and detailed hygiene measures were specified.

By 1900 cholera had ceased to be an epidemic problem in the UK and the Navy rapidly controlled the incidence thereafter (Figure 5). This was almost certainly by means of better arrangements for food and water procurements and limitations

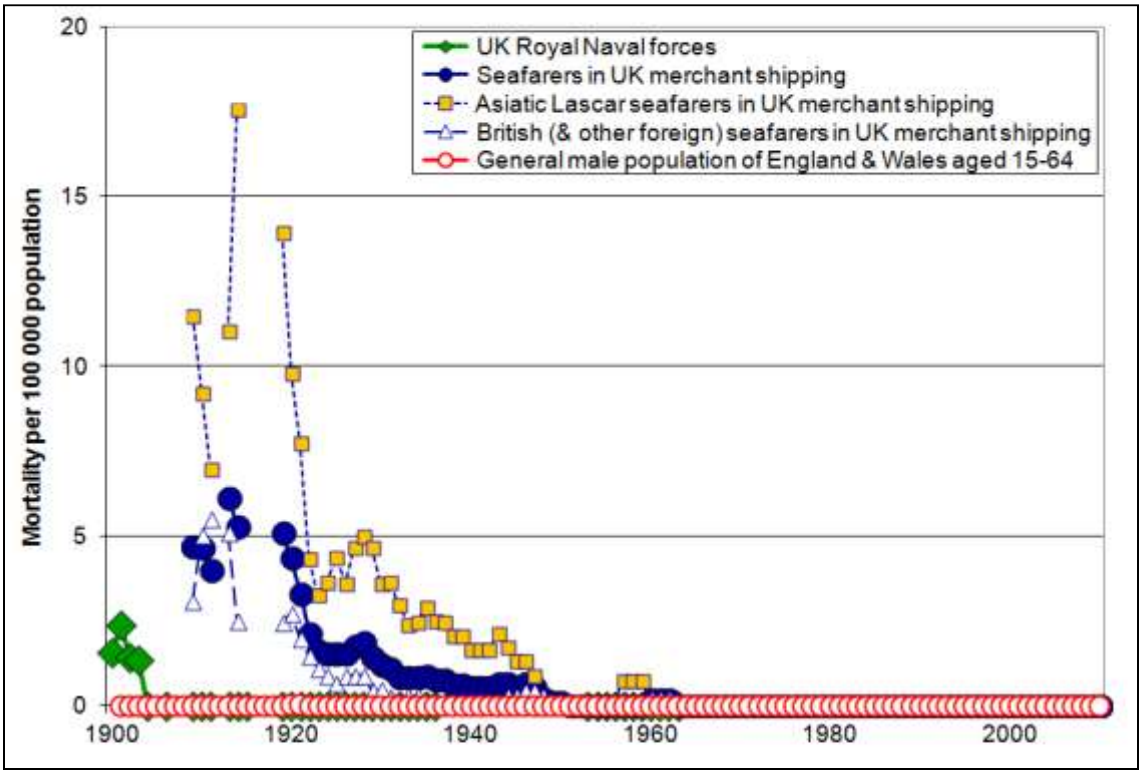
[18] Anne Hardy, 'Cholera, quarantine and the English preventive system, 1850-1895', *Medical History,* 37, No. 3 (1993), 250-69.

[19] B.E. Goodyer. 'An assistant ship surgeon's account of cholera at sea', *Journal of Public Health (Oxford),* 30, No. 3 (2008), 332-8.

[20] Gordon Cook, *Disease in the Merchant Navy* (Oxford, 2007), 192, 356.

placed on crew when in port cities with poor hygiene. By contrast, cholera continued to be reported among merchant seamen, although with a reducing frequency. The death rates in Asiatic crew continued to be higher than for others up to the 1950s, presumably because of the presence of endemic cholera in their home countries. Unfortunately it is not possible to identify how long after embarkation their illness occurred, as for such an acute infection this would give useful information on the source of infection.

Figure 5. Cholera Mortality Rates



Transmission by Air, Hands and Surface: Smallpox

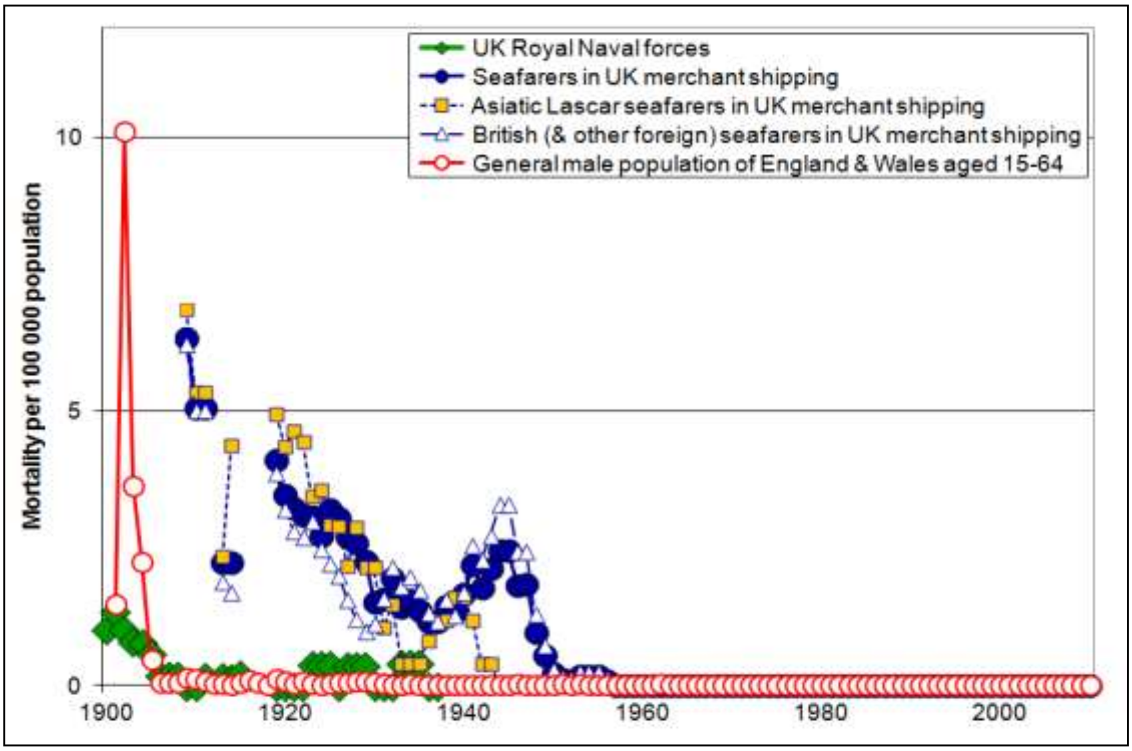
From the 1870s onwards there was repeated evidence that seamen were index cases in UK outbreaks of smallpox.[21] Vaccination was available throughout the period studied. While merchant seamen from the UK would usually have been

[21] Tim Carter, *Merchant Seamen's Health,* 80, 162.

vaccinated in childhood, there were no specific measures in place to re-vaccinate them later in life. Indeed the 1885 *SCMG* only advises vaccination 'where smallpox is prevalent'. There is no indication of any debate about routine pre-embarkation vaccination in the early twentieth century, however at a later time there was opposition to this from shipowners and their advisers because any complications from vaccination would usually occur after sailing.[22] The RN required regular re-vaccination.

The consequences of this difference in approach can be seen in the mortality rates and in their trends over much of the period studied (Figure 6). As smallpox became rarer and vaccination rates declined in the onshore population, the risks of transmission ashore from those who had partial immunity from childhood vaccination and so only developed a mild form of the infection, but who at the same time could transmit lethal infection to non-immune populations, became an issue. Since 1901 the *SCMG* had produced tables giving information on the differential diagnosis of

Figure 6. Smallpox Mortality Rates



[22] The National Archives, Kew (TNA). MT 9/5851/M2986/1949. Joint Advisory Committee, 16 Nov 1949.

smallpox and chickenpox and, in 1952, these were supplemented with coloured plates showing the nature and distribution of the rashes.

There were no consistent differences in mortality in Asian and non-Asian seafaring populations, despite continuing endemicity in parts of Asia. If there is a trend it is for higher incidence in the Asian Lascar seamen during the early part of the century changing to an excess in non-Asians later. The small increase during the Second World War may be attributable to defects in prevention at a time of disruption or to different patterns of trade and hence contact in ports.

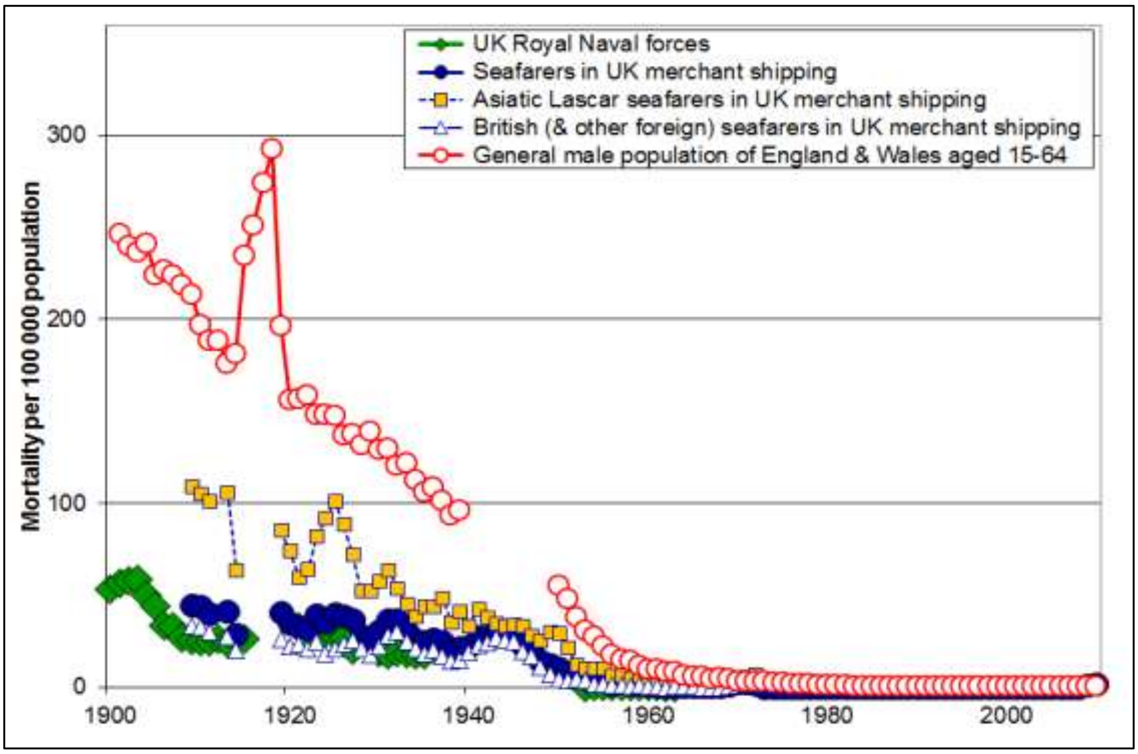
Transmission by Air, Hands and Surface: Tuberculosis

Because tuberculosis is not normally fatal in the short term, but is characterised by a prolonged period of disability or ill-health prior to death, mortality information for active seamen is unreliable as many will have ceased employment or obtained jobs ashore prior to death, and so their deaths will be recorded as part of the general population and not as occurring in seafarers. Unusually, for this condition mortality is higher in the onshore population than in the maritime ones (Figure 7) and this may well be explained by the move ashore either as a personal decision or as a consequence of medical selection prior to embarkation. Other studies confirmed a high incidence of deaths among those who had recently ceased to work as merchant seamen.[6]

The organism responsible for TB was identified in 1882. Earlier editions of *SCMG* had not noted an infectious origin, but by 1899 its spread by inhalation was noted and in 1901 poor ventilation aboard ships was considered to be a contributory cause. Ship owners were reluctant to accept the evidence from sources such as the military and from institutional living that better ventilation and more spacious accommodation could contribute to risk reduction. This was because of the economic implications of allocating more space to crew at the expense of cargo or passengers. The first antibiotic treatments were introduced in the 1940s.

Despite the limitations of the data it is noteworthy that the decline in mortality in the Navy and in non-Asian merchant seamen mirrored each other closely, with a continuing higher risk in Asiatic seamen. The latter was presumably a consequence of the higher tuberculosis rates in their home populations than in those from the UK.

Figure 7. **Tuberculosis Mortality Rates**

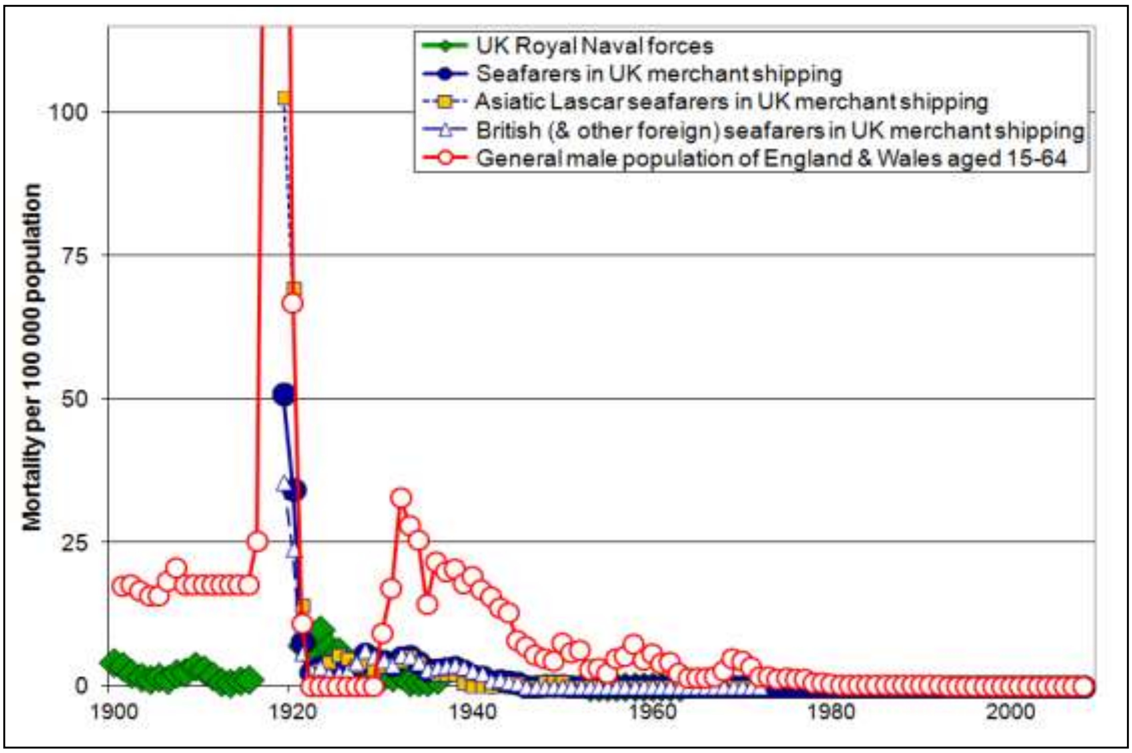


Transmission by Air, Hands and Surface: Influenza

Only the 1919 pandemic of influenza shows a mortality excess in merchant seamen (Figure 8). There are no naval records for this year. The rates ashore are higher than in seafaring groups, with smaller rises than in 1919 for a number of other epidemic years. The low rates at sea may be a consequence of a selected working population, who normally lack any of the predisposing factors for a fatal outcome from influenza infection. It may also reflect the limitations of diagnosis in this setting or even the lower rates of exposure to infection during time spent at sea rather than ashore.

The *SCMG* from 1901 to 1919 recommended general supportive treatment and noted the importance of person-to-person transmission, which was more frequent in moist weather. Later editions also recommended bed rest and isolation and noted the risk of pneumonia.

Figure 8. Influenza Mortality Rates



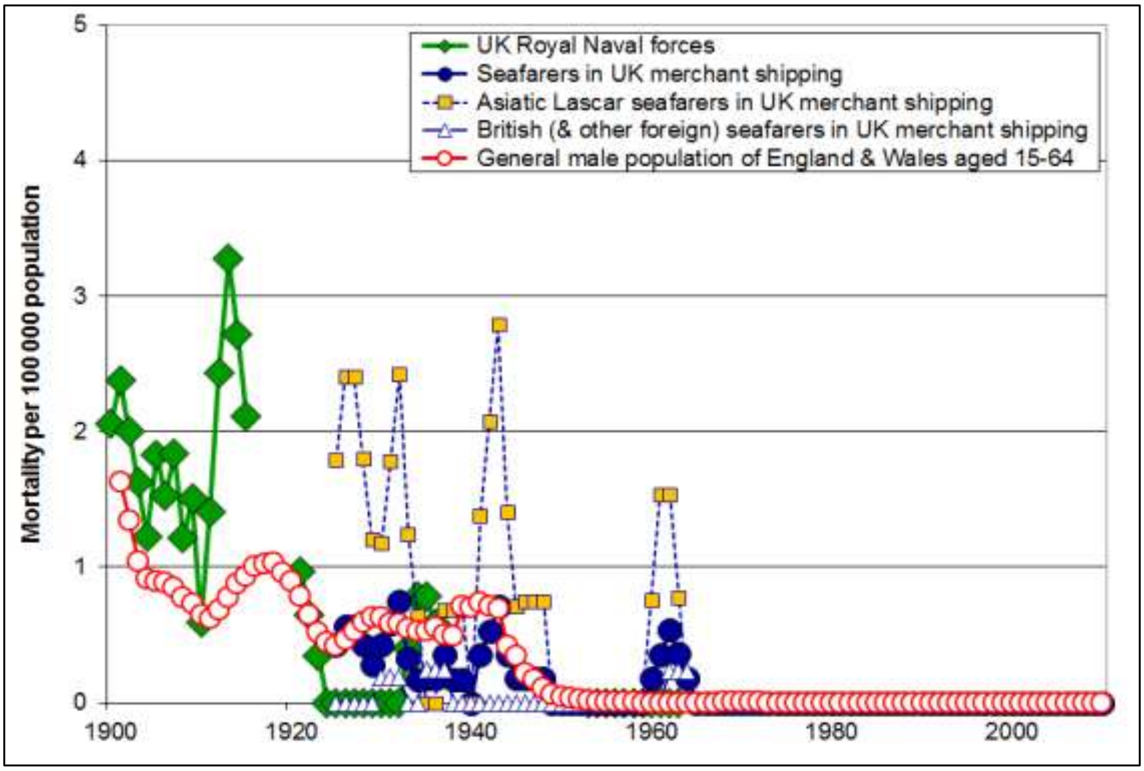
Notes
Although not shown for visual reasons, the mortality rate from influenza peaked in 1918 at 468 per 100 000 in the general male population of England & Wales aged 15-64 years and in 1919 at 167 per 100 000 among Asiatic Lascar seafarers.

Transmission by Air, Hands and Surface: Diphtheria

Diphtheria was a relatively infrequent cause of death in all the populations studied. The organism was identified in the 1880s and treatment with an antiserum had been available onshore from 1892, with immunisation introduced in the 1920s. In the early part of the century mortality was higher in the Navy than in the onshore population (Figure 9). Diphtheria was not classified in the death returns for merchant seamen before 1925 and there were no deaths recorded before 1930 in British seamen, but this may be an artefact of the recording system. Thereafter, fatal cases were more common in Asiatic Lascar seamen. The increase seen in 1960 represents three deaths, two in Lascars.

Diphtheria was described in the *SCMG* from 1901 onwards. Initially there was no mention of infectivity and precautions, and it was said to be associated with poor drainage, bad sanitary surroundings and sometimes milk. By 1912 it was described as very infectious, with instructions to isolate and avoid getting the membrane that developed in the throat or any discharges on sore places on the skin. In 1929 the use of antiserum was commended but with the note that it could only be given on ships with a doctor. The need for tracheotomy in severe cases was noted.

Figure 9. Diphtheria Mortality Rates



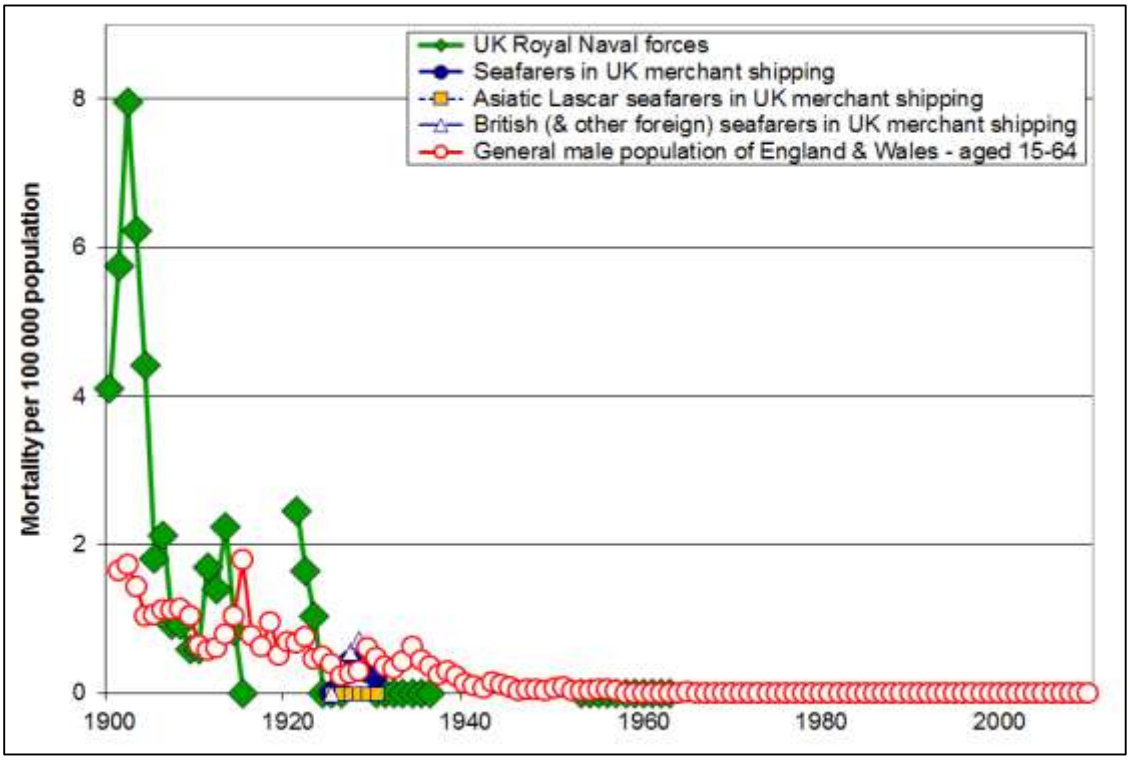
Notes
Diphtheria was not included in death returns for UK merchant shipping prior to 1925.

Transmission by Air, Hands and Surface: Scarlet Fever

Scarlet Fever mortality data for merchant seamen were not available before 1925. By this time the causal link to haemolytic streptococcus infections, usually of the throat, had been identified and the Dick test for diagnosis developed. The relatively high mortality from both this condition and from diphtheria in the Navy – during the earliest study years (Figure 10) – may be attributable to the relatively large numbers of susceptible teenage recruits.

Scarlet fever was first described in the 1885 *SCMG* when it was noted to be very infectious, especially when there was skin peeling; this led to long periods of isolation. The risk of kidney disease was also recorded, while in 1912 the risk of associated rheumatism (rheumatic fever, affecting the heart valves) was noted. Much later, in 1952, treatment with the antibacterial sulphadimidine was recommended.

Figure 10. Scarlet Fever Mortality Rates



Notes
Scarlet fever was not recorded in death returns for UK merchant shipping prior to 1925.

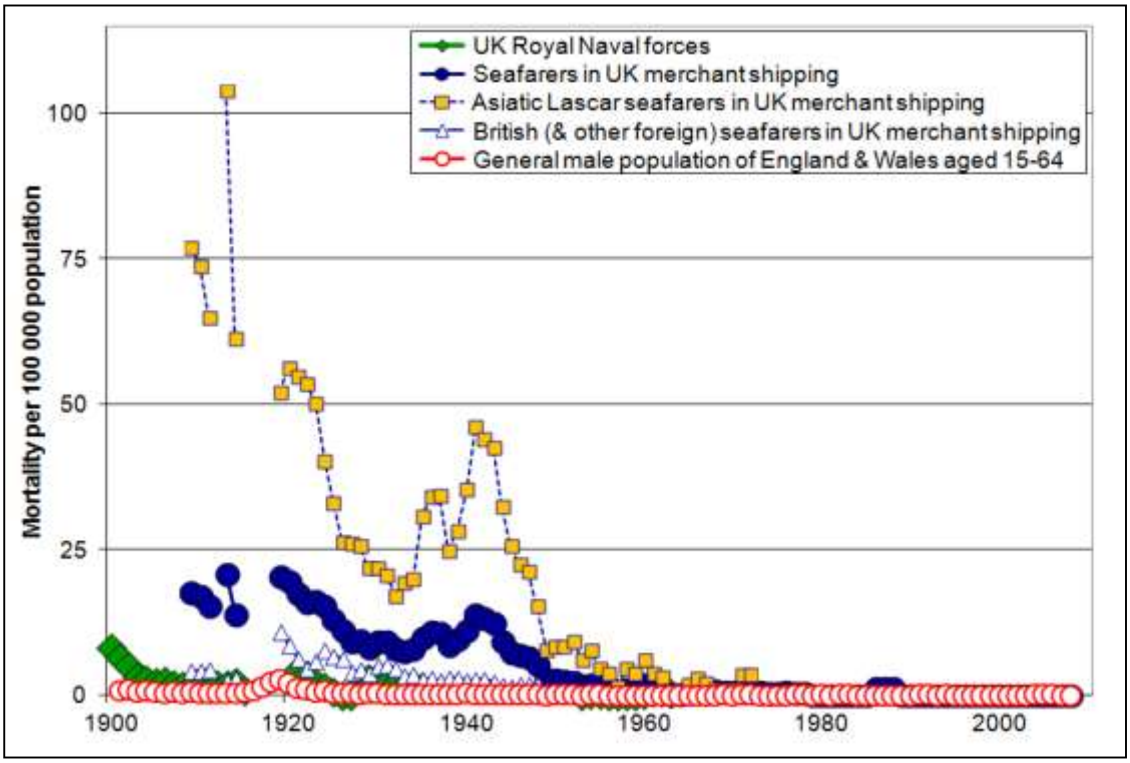
Transmission by Arthropod Vector: Malaria

Prior to the identification of the causative organism, the diagnostic terminology for malaria was complex: ague, malaria, remittent fever and blackwater fever were among the terms used. Its association with certain tropical shores had been known for several centuries and use of quinine for treatment was long established.

However, in the absence of knowledge about mosquito transmission, preventative methods were limited to anchoring at a distance from shore and limiting time ashore. In 1885 the *SCMG* said that the cause was ‘breathing a poison contained in marshy ground termed malaria’.

The life cycle of the parasite and mosquito transmission were recognised in 1897, and by 1901 the *SCMG* linked malaria to mosquitoes and noted the rules for protection against bites. From 1912 the *SCMG* recommended quinine for prevention as well as treatment. The development of Atebrin/Mepacrine, the first synthetic antimalarial, and the synthesis of the insecticide DDT in the 1930-40s greatly enhanced prevention. The Second World War saw extensive studies on risks to seamen in West African ports with the introduction of local control measures.[23] The increased mortality in Lascars during this period (Figure 11) could reflect changed shipping routes that resulted in more time spent in high risk countries for malaria infections, particularly in West Africa, poor compliance with prophylaxis or an increased incidence in their home countries.

Figure 11. Malaria Mortality Rates



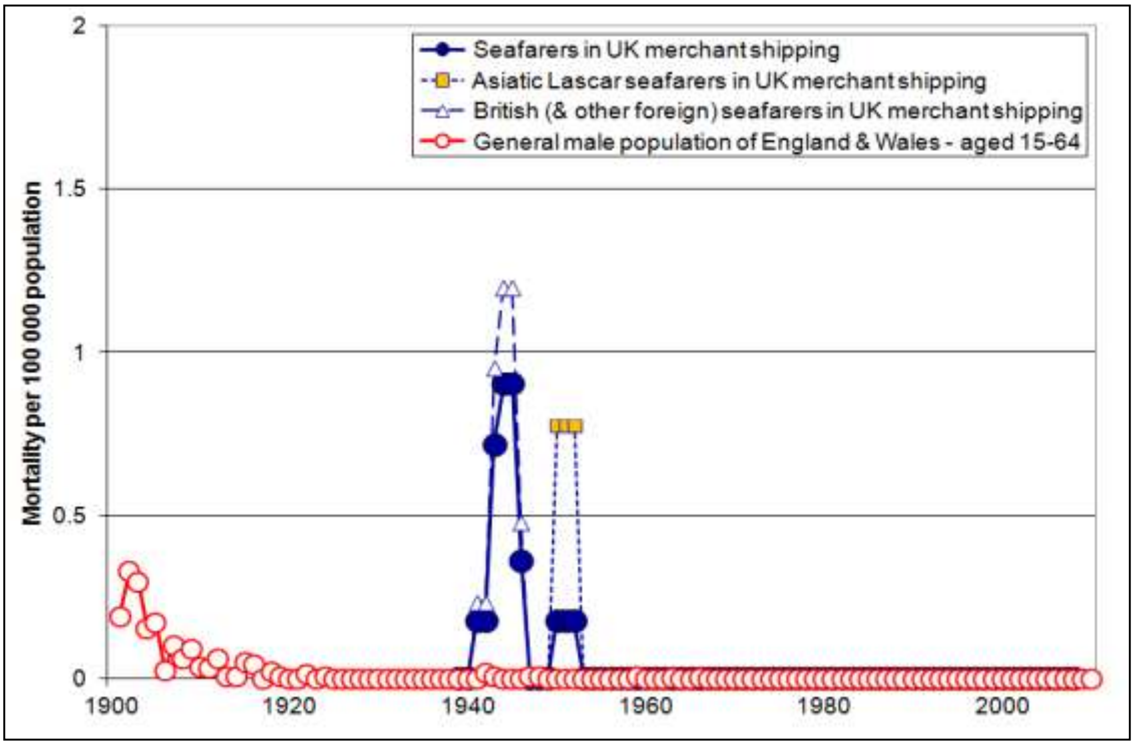
[23] A. Gardner. Malaria among Merchant Seamen. *British Medical Journal.* 1941(i),134.

Control appears to have been earlier and more effective in the RN, but when the Asiatic and non-Asiatic populations of merchant seamen are compared much of the excess mortality is in the Asians and this could be partly explained by latent infection from home countries becoming active while at sea. However, if this was the case, it is surprising that the incidence increases so much in the early 1940s, during the Second World War, while a similar increase is not seen in other merchant seamen.

Transmission by Arthropod Vector: Typhus

Despite the historical importance of 'ship fever', a diagnosis later equated to typhus, as a major cause of mortality in the Navy a century earlier, typhus was no longer a category used for recording mortality during the period of this study. Similarly it was not recorded as a cause of death in merchant shipping until 1939. A small number of fatal cases occurred during the 1940s and very early 1950s (Figure 12).

Figure 12. Typhus Mortality Rates



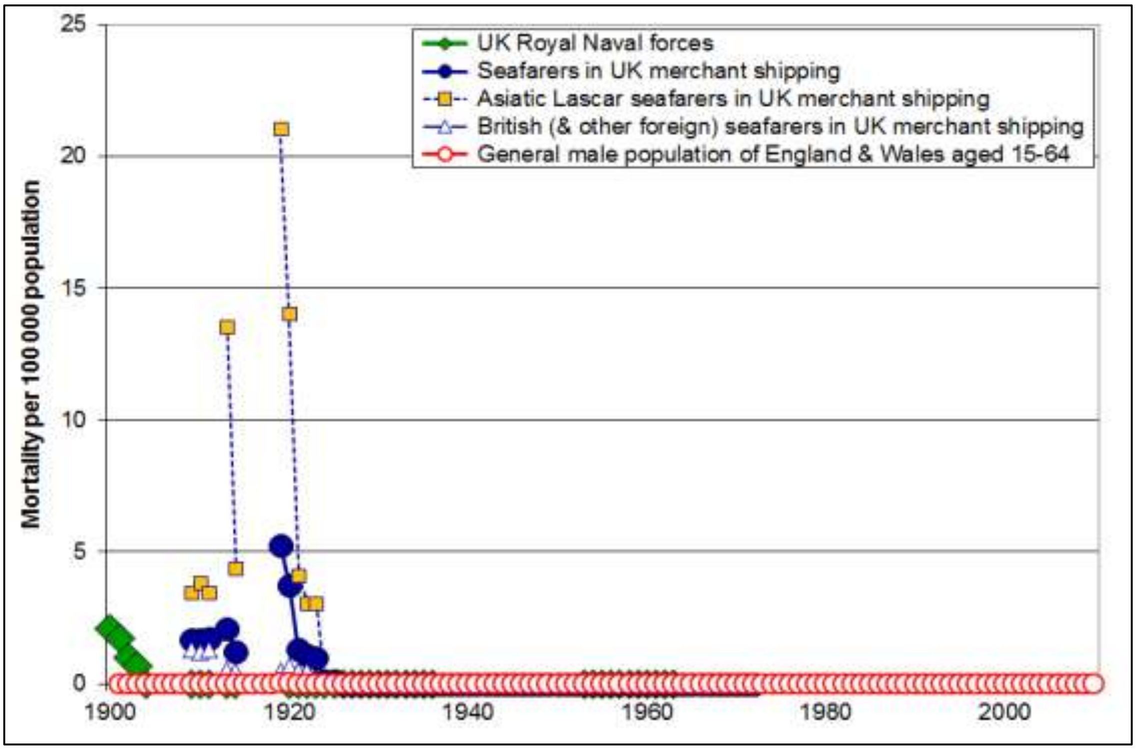
Notes
Typhus was not recorded in death returns for the Royal Navy or in UK merchant shipping prior to 1939.

The *SCMG* had always included typhus, initially as one of the forms of 'continuing fever', the other being typhoid. In 1885 the *SCMG* noted that it was very infectious and associated with overcrowding and bad ventilation – with recommendations to disinfect crew quarters if the disease was found. In 1909 transmission by the body louse was recognised, and the 1916 *SCMG* stated that it was actively propagated by lice, advising that insecticides be used freely. In 1943 DDT was stated to be effective in stopping epidemics.

Transmission by Arthropod Vector: Plague

Fatal plague cases in the Navy were not seen after 1910 (Figure 13). Cases continued until the 1920s in merchant seamen, most being in Lascars, probably because it remained endemic in the port cities of Asia. The control of rat populations became a key preventative measure, as infection among rats in ports was common. Rats readily infest ships carrying grain and similar cargoes. Fumigation regimes and de-ratting precautions became mandatory, as did rat guards on mooring ropes.

Figure 13. Plague Mortality Rates



Plague was not mentioned in the *SCMG* until 1899, when a new pandemic was spreading around the world. The *Guide* then noted that rats and mice carry infection and so should be destroyed. Shortly before this time the bacterium and the role of the rat flea as a vector had both been recognised. Later editions noted the role of the *Cheops* flea as a carrier and characterised plague as primarily a disease of rats that was transmissible to man.

Transmission by Arthropod Vector: Yellow Fever

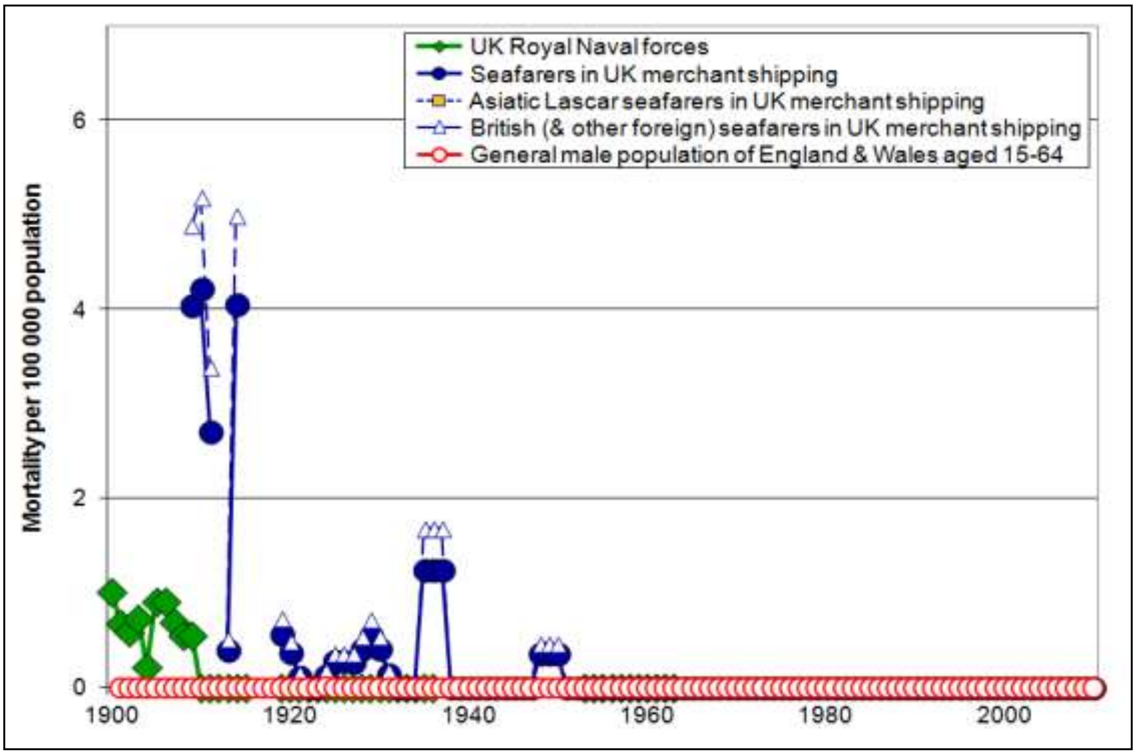
All editions of the *SCMG* described yellow fever. In 1868 it noted that the fever only occurred where temperatures were above 75 degrees F. In September 1865, the only known transmission of yellow fever within the UK, and only one of two in northern Europe, occurred during a prolonged period of abnormally hot weather, after a ship returned with a copper ore cargo from Cuba to South Wales with several crew already dead or morbid with yellow fever. There were subsequently 15 deaths out of 28 infected in two port town populations,[24] and the cargo ship *The Barque* was subsequently destroyed by fire offshore.

Transmission by mosquito was demonstrated in 1900 but the *SCMG* was slow to respond to this finding and in 1901 noted that infection was transmitted in vomit. However by 1912 it said that the *Stegomia* mosquito carried the infection if it had bitten an infected person in first three days of illness. Anti-mosquito precautions plus draining or covering any fresh water pools on board are recommended.

Later developments included the long delayed recognition, in 1914, that bulk cargoes can harbour mosquitoes leading to secondary cases. This explained a number of anomalous cases that occurred many days away from infected ports such as the 1865 outbreak in South Wales. In 1935 immunisation was introduced. The 1952 *SCMG* notes that an inoculation certificate is required for entry into some ports and the use of insecticides and other bite avoidance measures in recommended.

[24] C.E. Gordon Smith and Mary E. Gibson, ‘Yellow fever in South Wales, 1865’, *Medical History,* 30 (1986), 322-40; P.D. Meers, ‘Yellow fever in Swansea, 1865’, *Journal of Hygiene (London),* 97 (1986), 185-91.

Figure 14. Yellow Fever Mortality Rates



Body Fluid Transmission: Syphilis

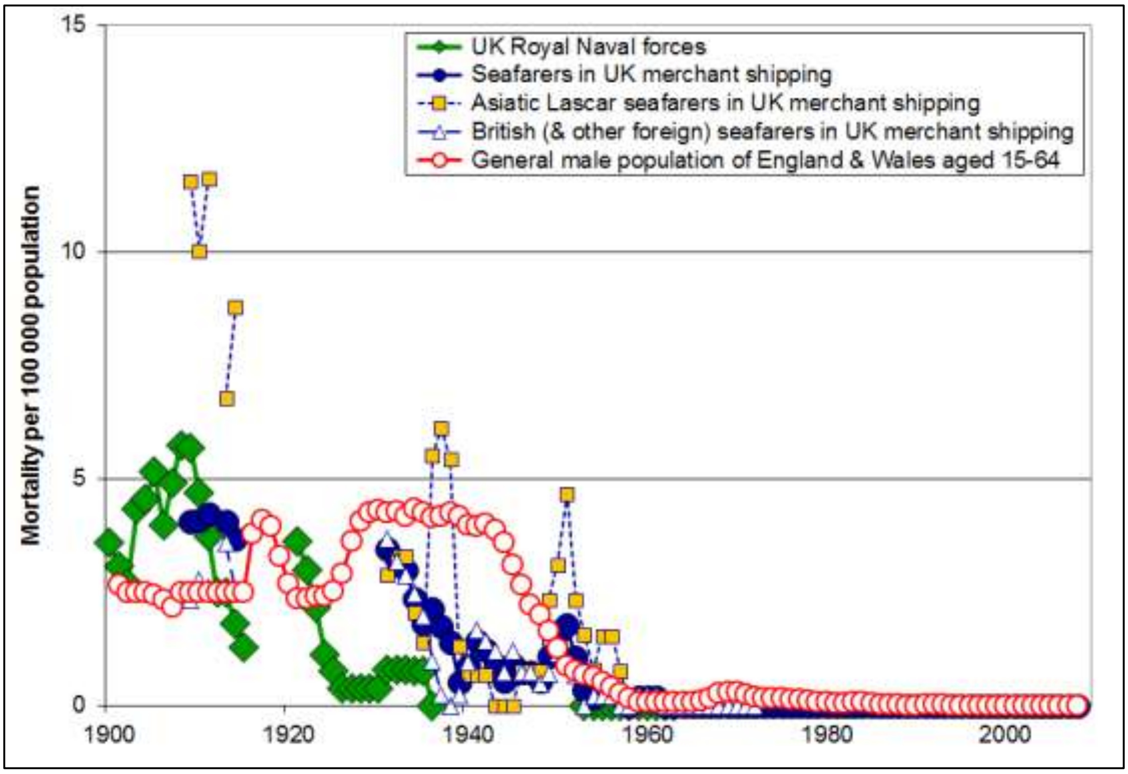
Like tuberculosis, death from syphilis normally occurs many years after the initial infection and often after a period when the seafarer has either retired from work at sea or has been forced to leave it because of associated medical problems. This means that mortality data are unreliable, and in the case of syphilis this may be further complicated by a reluctance to name the condition on a death certificate. The use of condoms and other forms of protection was also controversial during the first half of the twentieth century, with some reformers advocating widespread availability, while others were against such approaches as they were seen as encouraging promiscuous sex and the exploitation of women.[25] The lack of agreement to provide

[25] Paul Weindling, 'The Politics of International Co-ordination to combat sexually transmitted diseases, 1900-1980s', in Virginia Berridge and Philip Strong, eds., *Aids and Contemporary History* (Cambridge, 1993), 93-107.

condoms for merchant seamen until the 1940s may well have led to some of the recorded fatalities.[26]

The recorded mortality trends are complex, with the Navy having high rates in the first few years of the century followed by a sustained reduction (Figure 15). Trends in general population mortality are not readily explained, with the exception of the rapid reduction in the late 1940s and 1950s after penicillin became available. Several of the peak years among merchant seamen seem to be associated with multiple deaths in Lascars, although this defies easy explanation. One contributory factor to some of these trends may be the availability and continuity of treatment with pre-penicillin anti-syphilitics such as Salvarsan. This may explain the consistent downward trend in the Navy during the 1920s.

Figure 15. Syphilis Mortality Rates



Notes
Syphilis was not recorded in death returns for UK merchant shipping between 1915 and 1930.

[26] Tim Carter, *Merchant Seamen's Health,* 145.

Discussion and Conclusions

The description of trends in infectious disease among British merchant seamen and its comparison to the Royal Navy and to the onshore male working age population provides insights into the pattern of risks experienced in what was probably the occupational group at highest risk of infectious disease during the study period. It places this excess in the context of working and living conditions aboard merchant ships as well as the state of knowledge about prevention, diagnosis and treatment. It also enables the specific features of each of the infections that are often major causes of mortality to be assessed and their differential impact on Asiatic contract (Lascar) and other merchant seamen to be evaluated. The study was limited to those well-defined infectious diseases that were consistently classified by name in the available annual death returns. Non-specific infections such as pneumonias, septicaemias and abscesses were not included.

A number of consistent features are apparent that are relevant to more than one of the infectious diseases analysed. First, the quality of evidence used to diagnose cause of death will be more reliable where medical skills were routinely available, as was the case ashore and in the Navy. Deaths in merchant seamen may have been recorded by port doctors and relayed by a British consul or they will have been reported by a ship's officer with only very limited training in medical care. In earlier years of the study period, sea burials without medical examinations ashore were also more common. This may have introduced bias into the recorded pattern of mortality. Bias is most likely when signs and symptoms could be confused, as in typhoid and typhus or smallpox and chickenpox, or where the officer had a stereotyped view of mortality patterns, such as the use of malaria as a diagnosis in Lascars who died of a febrile illness. Moreover, where the course of the illness was prolonged, as in tuberculosis and syphilis, records of seafarer mortality provide an unreliable guide to overall mortality. Death commonly occurred after termination of service, either because of early symptoms and illness, or following retirement from seafaring or other discharges ashore. The mortality rates from these conditions in maritime settings may, however, provide a weak indication of trends.

For most acute infections, mortality was much higher than in the general population. This is especially the case where the infection is one that depends on a vector sensitive to climatic conditions such as malaria or yellow fever. The exceptions are for chronic conditions such as tuberculosis and syphilis.

Mortality rates reduced earlier and faster in the Navy than in merchant seamen. This may be a consequence of earlier recognition of problems, but it almost certainly reflects the ability of a unified disciplined service to introduce generally applicable improvements to prevention and treatment speedily. This centralised and effective form of control was absent in commercially motivated and competitive merchant shipping, where labour was not always seen as an asset to be protected and conserved. In addition the Navy was better placed to specify standards for food and water supplies in ports where hygiene was poor than was a local shipping agent acting on behalf of a merchant vessel due to dock there. To take smallpox as a case in point, the difference in incidence between the navy and merchant seamen was almost certainly a consequence of compulsory vaccination for all those in the Navy. For most of the period it was recommended for merchant seamen, but without any pressure for compliance. It could be speculated that the decrease in mortality from diphtheria in naval personnel and in non-Lascar merchant seamen resulted from the use of immunisation while the continuing mortality in Lascars was in a non-immunised population.

For a number of conditions the rates in Lascar merchant seamen were consistently higher than those in non-Lascars. As most infections studied are acute it would be interesting to know how much of this excess arose soon after the start of a contract, but this information is not available. For a few conditions such as malaria and amoebic dysentery it is possible that the disease leading to death re-emerged long after embarkation. The excesses in Lascars are seen especially in diseases that are endemic to, or more commonly epidemic in, South Asia. It is not, for instance, seen for yellow fever, a disease of tropical Africa and the Americas. For those infections that did not have an increased incidence in South Asia, such as smallpox or which remained common in the UK, such as influenza and typhoid there were no marked differences between Lascars and non-Lascars.

The trend in mortality for all infectious diseases over the study period is downward. The provision of new information on prevention, diagnosis or treatment in the *SCMG* cannot be linked to any sharp changes in mortality among merchant seamen as compared to other groups. This is not surprising as the complexity of geographical, ship design and medical features will all have played a part in reducing mortality, as did the reduction in transmission to seafarers as incidence ashore declined due to improvements in public health, sanitation and food and water quality. The availability of antibiotics from the 1940s onwards almost certainly played an important part in mortality reduction, not only for the infectious diseases studied, but also for other less specific infections.

Some effects from both World Wars can be seen in the patterns of mortality from infectious disease, for instance the increase in dysentery and influenza during the first war and the increase in malaria and smallpox during the second. During the Second World War some specific disease control programmes were adopted for merchant seamen, notably for malaria, syphilis and tuberculosis.[27] These do not show in the mortality trends as they coincided with the introduction of more effective approaches to prophylaxis and to chemotherapy for these conditions.

During earlier years of the twentieth century, infectious diseases formed a significant proportion of the deaths in serving seafarers. This is no longer the case as, in parallel with the onshore population, vascular diseases now account for most fatal diseases. Deaths from injury and from ship disasters remain but have also reduced in frequency.[28]

[27] Tim Carter, *Merchant Seamen's Health,* 142.

[28] Stephen E. Roberts and Judy C. Williams, *Update of Mortality for Workers in the UK Merchant Shipping and Fishing Sectors.* Research Project 578. Southampton: Maritime and Coastguard Agency, 2007.

Author biographies

Tim Carter is currently a professor at the Norwegian Centre for Maritime Medicine, University of Bergen; he was until recently the Chief Medical Adviser to the Maritime and Coastguard Agency, and has been a special adviser to the International Labour Organization and the International Maritime Organization, assisting with the revision of international guidelines on seafarer medical examinations. Earlier in his career he trained as an occupational physician and worked first in the petrochemical industry and then as Medical Director of the UK Health and Safety Executive. He has also worked on driver fitness with the Department for Transport and as a consultant with industry, governments and international agencies.

Stephen E Roberts is a reader in public health and epidemiology at Swansea University Medical School and was previously a research lecturer at the Department of Public Health, University of Oxford. He is deputy editor of International Maritime Health, Gdynia, and has published widely on fatal accidents and injuries, diseases, suicides, homicides and maritime disasters in merchant shipping and sea fishing. He has led reviews of gastrointestinal diseases across Europe for United European Gastroenterology and the European Society for Paediatric Gastroenterology, Hepatology and Nutrition, as well as projects on mortality following acute diseases across England and Wales for the Wellcome Trust, The Health Foundation and the Royal College of Physicians.

Table 1. **Numbers of deaths and mortality rates from infectious diseases in UK merchant shipping, 1909-2**

Infectious disease	1909-1914 ‡		1919-1929		1930-1938		1939-1945		1946-1949		1950-1959	
	No. of deaths	(rate per 100 000)	No. of deaths	(rate per 100 000)	No. of deaths	(rate per 100 000)	No. of deaths	(rate per 100 000)	No. of deaths	(rate per 100 000)	No. of deaths	(rate per 100 000)
Seafarers in UK Merchant shipping:												
Tuberculosis	472	39.6	935	34.6	517	29.3	338	25.7	129	17.7	83	4.4
Typhoid	266	22.3	318	11.8	99	5.6	66	5.0	19	2.6	9	0.5
Cholera	71	6.0	65	2.4	15	0.8	9	0.7	2	0.3	0	0.0
Diphtheria †			4	0.1	7	0.4	4	0.3	1	0.1	0	0.0
Dysentery	156	13.1	161	6.0	56	3.2	40	3.0	15	2.1	12	0.6
Malaria	206	17.3	385	14.4	164	9.3	142	10.8	39	5.3	33	1.7
Syphilis †	48	4.0			37	2.1	11	0.8	5	0.7	13	0.7
Influenza	0	0.0	345	12.8	64	3.6	17	1.3	1	0.1	0	0.0
Smallpox	47	3.9	81	3.0	23	1.3	29	2.2	5	0.7	1	0.1
Yellow fever	41	3.4	8	0.3	8	0.5	0	0.0	2	0.3	0	0.0
Typhus †							6	0.5	0	0.0	1	0.1
Scarlet fever †			5	0.2	0	0.0	0	0.0	0	0.0	0	0.0
Plague	22	1.8	36	1.3	0	0.0	0	0.0	0	0.0	0	0.0
British & other foreign seafarers:												
Tuberculosis	269	27.7	455	21.9	286	21.9	222	22.7	79	14.2	31	2.1
Typhoid	248	25.5	267	12.9	69	5.3	54	5.5	15	2.7	2	0.1
Cholera	54	5.6	29	1.4	2	0.2	2	0.2	2	0.4	0	0.0
Diphtheria †			4	0.2	5	0.4	4	0.4	1	0.2	0	0.0
Dysentery	80	8.2	94	4.5	38	2.9	21	2.1	9	1.6	8	0.5
Malaria	170	17.5	252	12.3	113	8.6	120	12.2	29	5.2	27	1.8
Syphilis †	28	2.9			22	1.7	10	1.0	4	0.7	5	0.3
Influenza		0.0	203	9.8	49	3.7	16	1.6	0	0.0	0	0.0
Smallpox	37	3.8	54	2.6	19	1.5	28	2.9	5	0.9	1	0.1
Yellow fever	41	4.2	8	0.4	8	0.6	0	0.0	2	0.4	0	0.0
Typhus †							6	0.6	0	0.0	0	0.0
Scarlet fever †			5	0.2	0	0.0	0	0.0	0	0.0	0	0.0
Plague	9	0.9	5	0.2	0	0.0	0	0.0	0	0.0	0	0.0
Lascars:												
Tuberculosis	203	92.4	480	76.3	231	50.7	116	34.8	50	28.7	52	12.0
Typhoid	18	8.2	51	8.1	30	6.6	12	3.6	4	2.3	7	1.6
Cholera	17	7.7	36	5.7	13	2.9	7	2.1	0	0.0	0	0.0
Diphtheria †			0	0.0	2	0.4	0	0.0	0	0.0	0	0.0
Dysentery	76	34.6	67	10.7	18	3.9	19	5.7	6	3.4	4	0.9
Malaria	36	16.4	133	21.1	51	11.2	22	6.6	10	5.7	6	1.4
Syphilis †	20	9.1			15	3.3	1	0.3	1	0.6	8	1.8
Influenza		0.0	142	22.6	15	3.3	1	0.3	1	0.6	0	0.0
Smallpox	10	4.6	27	4.3	4	0.9	1	0.3	0	0.0	0	0.0
Yellow fever	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Typhus †							0	0.0	0	0.0	1	0.2
Scarlet fever †			0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Plague	13	5.9	31	4.9	0	0.0	0	0.0	0	0.0	0	0.0

Notes

* The populations of Lascar and other crews were not distinguished after 1972

‡ Excludes 1912

† Typhus was not recorded in the annual death returns for seafarers in UK merchant shipping before 1939, diphtheria and scarlet fever were not recorded be
included under “venereal diseases“ from 1909 to 1914

Table 2. **Numbers of deaths and mortality rates from infectious diseases in the Royal Navy, 1900-1963**

Infectious disease †	1900-1915		1921-1929		1930-1938		1953-1963	
	No. of deaths	(rate per 100 000)	No. of Deaths	(rate per 100 000)	No. of deaths	(rate per 100 000)	No. of deaths	(rate per 100 000)
Tuberculosis	678	35.1	224	26.8	110	18.2	1	0.1
Typhoid	603	31.3	36	4.3	5	0.8	0	0.0
Cholera	7	0.4	0	0.0	0	0.0	0	0.0
Diphtheria	36	1.9	2	0.2	2	0.3	0	0.0
Dysentery	121	6.3	5	0.6	3	0.5	0	0.0
Malaria	52	2.7	18	2.2	12	2.0	1	0.1
Syphilis	69	3.6	12	1.4	4	0.7	0	0.0
Influenza	37	1.9	35	4.2	7	1.2	0	0.0
Smallpox	7	0.4	2	0.2	1	0.2	0	0.0
Yellow fever	6	0.3	0	0.0	0	0.0	0	0.0
Scarlet fever	45	2.3	6	0.7	0	0.0	0	0.0
Plague	6	0.3	0	0.0	0	0.0	0	0.0

Notes

† Typhus was not classified in the annual death returns for the Royal Navy

Table 3. **Trends over time in relative risks of mortality from infectious diseases: seafarers employed in UK merchant shipping compared with the general working age male population of England & Wales, 1909-2010**

	Relative risk of mortality (UK merchant shipping: general working age male population)								
	Time period								
Infectious disease	**1909-14‡**	**1919-29**	**1930-38**	**1939-45**	**1946-49**	**1950-59**	**1960-69**	**1970-**	**Total**
All seafarers in UK merchant shipping:									
Tuberculosis	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.4	0.4
Typhoid	2.3	7.1	7.9	16.0	23.7	24.9	10.8	0.0	9.5
Cholera	3317	391	*	*	*	*	*	*	1734
Diphtheria †		0.6	0.7	0.5	1.2	0.0	291	0.0	1.3
Dysentery	16.7	8.6	10.2	7.4	11.3	9.0	10.8	30.2	20.6
Malaria	41.8	17.5	62.3	77.4	80.5	46.6	50.2	22.1	58.2
Syphilis †	1.4		0.5	0.2	0.3	1.4	0.5	0.0	0.8
Influenza		0.9	0.2	0.1	0.0	0.0	0.0	0.0	0.5
Smallpox	57.8	58.3	120	*	72.2	8.3	0.0	0.0	142
Yellow fever	*	397	*	*	*	*	*	*	6276
Typhus †				119	0.0	82.4	0.0	*	55.1
Scarlet fever †		1.4	0.0	0.0	0.0	0.0	0.0	*	1.9
Plague	514	293	*	*	*	*	*	*	771
British & other foreign Seafarers:									
Tuberculosis	0.5	0.5	0.5	0.4	0.4	0.5	0.4	**	0.6
Typhoid	0.9	4.9	9.3	11.5	20.9	93.8	0.0	**	4.2
Cholera	4312	946	*	*	*	*	*	**	2210
Diphtheria †		0.0	0.8	0.0	0.0	0.0	808	**	0.6
Dysentery	44.1	15.4	12.6	13.8	18.9	14.5	30.0	**	25.7
Malaria	39.7	25.7	75.0	47.2	86.4	41.0	55.8	**	44.6
Syphilis †	3.2		0.8	0.1	0.3	3.8	0.6	**	1.0
Influenza		1.5	0.2	0.0	0.1	0.0	0.0	**	0.7
Smallpox	66.7	83.5	81.0	*	0.0	0.0	0.0	**	91.5
Yellow fever	*	0.0	*	*	*	*	*	**	0.0
Typhus †				0.0	0.0	362	0.0	**	25.2
Scarlet fever †		0.0	0.0	0.0	0.0	0.0	0.0	**	0.0
Plague	1649	1086	*	*	*	*	*	**	1665
Lascars:									
Tuberculosis	0.1	0.2	0.2	0.2	0.2	0.1	0.1	**	0.2
Typhoid	2.7	7.8	7.5	17.5	24.5	7.9	14.2	**	7.0
Cholera	3094	231	*	*	*	*	*	**	835
Diphtheria †		0.8	0.7	0.7	1.6	0.0	128	**	1.0
Dysentery	10.5	6.6	9.3	5.2	8.9	8.5	4.7	**	10.1
Malaria	42.4	15.0	57.9	87.6	78.6	54.4	48.4	**	37.3
Syphilis	1.0		0.4	0.3	0.3	0.7	0.0	**	0.5
Influenza		0.7	0.2	0.1	0.0	0.0	0.0	**	0.3
Smallpox	55.8	50.6	134	*	94.9	11.9	0.0	**	96.2
Yellow fever		510	*	*	*	*	*	**	5476
Typhus †				159	0.0	0.0	0.0	**	46.4
Scarlet fever †		1.8	0.0	0.0	0.0	0.0	0.0	**	1.6
Plague	258	53	*	*	*	*	*	**	162

Notes

* Denotes no fatalities in the general male working age population of England & Wales

** The populations of Lascar and other crews were not distinguished after 1972

‡ Excludes 1912

† Typhus was not recorded in the annual death returns for seafarers in UK merchant shipping before 1939, diphtheria and scarlet fever were not recorded before 1925 and syphilis was not classified separately among seafarers before 1931 but was included under “venereal diseases “ from 1909 to 1914

Table 4. **Trends over time in relative risks of mortality from infectious diseases: Royal Navy compared with the general working age male population of England & Wales, 1901-2010**

	Relative risk of mortality (Royal Navy: general working age male population)				
	Time period				
Infectious disease †	**1901-1915**	**1921-1929**	**1930-1936**	**1953-1963**	**Total**
Tuberculosis	0.2	0.2	0.2	0.0	0.1
Typhoid	2.6	2.9	1.1	0.0	2.4
Cholera	576	0.0	*	*	115
Diphtheria	2.2	0.5	0.6	0.0	1.3
Dysentery	6.6	1.2	1.5	0.0	4.3
Malaria	5.2	4.0	13.3	3.6	4.3
Syphilis	1.4	0.5	0.2	0.0	0.6
Influenza	0.1		0.1	0.0	0.1
Smallpox	0.3	5.5	12.8	0.0	0.4
Yellow fever	*	0.0	*	*	494
Scarlet fever	2.1	1.6	0.0	0.0	1.6
Plague	247	0.0	*	*	247

Notes
* Denotes no fatalities in the general male working age population of England & Wales
† Typhus was not recorded in the annual death returns for the Royal Navy